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(64) Stabilizer for bisphenols and process of using same.

(57) Lactic, malic and glyceric acids have been found to be superior to the hydroxy carboxylic acids heretofore employed for stabilizing bisphenols. The hydroxy carboxylic acids of the present invention or their ammonium or alkali metal salts can be added to the feed reactants used to make a bisphenol or to the reaction mixture after the reaction is complete or at any point in between. Lactic, malic and glyceric acids are particularly useful when the bisphenol is exposed to high temperatures, e.g. during the separation of the bisphenol from the reaction mixture or in a melt.

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## STABILIZER FOR BISPHENOLS AND PROCESS OF USING SAME

Most polymers are generally thought to be heat and oxygen sensitive and tend to degrade to form degradation products which have an adverse effect on the color of the polymers, as well as the physical properties of the polymers. Bisphenols, which are important in the preparation of epoxy resins and polyesters, are also known to be heat and oxygen sensitive, and when subjected to heat and/or oxygen, bisphenols form degradation products which adversely affect polymers subsequently made from the bisphenols containing these degradation products. Thus, bisphenol A is known to decompose with heat to form degradation products such as phenol and p-isopropylidene phenol. Additional heating of bisphenol A can cause formation of other degradation products such as complex non-volatile compounds. These degradation products from bisphenol A, even in small concentrations, can cause a lowering of the molecular weight of polyesters prepared from bisphenol A. Some of the degradation products formed in bisphenol can cause undesirable color in the bisphenol itself during its purification and in epoxy resins and/or polyesters since both purification and manufacturing processes employing bisphenol involve heating.

Stabilization of polymers from thermal degradation is believed to be achieved by incorporating a primary radical scavenger, usually a phenolic derivative. To combat the oxidation of the polymer one also must use a hydroperoxide decomposer together with the radical scavenger. Representative of hydroperoxide decomposers are thioesters and phosphites, such as dilaurylthiodipropionate and tri(nonylphenyl)-phosphite. One reference, J. Appld. Polym. Sci., Vol. 27, 951-955 (1982), reports the investigation of tetrakis(2,4-di-tert-butylphenyl)4,4'-biphenylene diphosphonite (SANDOSTAB PEPQ, a trademark of Sandoz Corporation) as both a hydroperoxide decomposer and a primary radical scavenger.

The presence of metal ions in bisphenol is also thought to have an adverse affect on the color of bisphenols, probably by promoting degradation. Various other additives have been employed to inhibit the formation of degradation products in bisphenols. Thus, alkaline earth phosphates, stannous oxide and oxalate, tin powder and tin dioxide, terephthalic and isophthalic acids, oxalic, sebacic and adipic acids and boron and antimony trioxides and their mixtures are useful additives for providing thermal stability to bisphenols as taught in British Patent No. 890,432.

Another British Patent No. 1,022,583, teaches that improved color stability is provided to bisphenols by incorporating oxalic, citric or tartaric acids or their alkali metal or ammonium salts in bisphenols during the bisphenol manufacturing process. It also teaches that the acids themselves or their ammonium salts are preferred and the acids or salts thereof may be added to the reactants for making bisphenol or to the reaction mixture after the reaction is complete, but before the bisphenol is separated from the reaction mixture.

U. S. Patent No. 3,629,339 teaches stabilizing phenols and bisphenols with an inorganic arsenic compound such as arsenic trioxide or ammonium and alkali metal arsenites.

U. S. Patent No. 4,160,110 teaches that various phthalic anhydrides are useful as distillation inhibitors against degradation of bisphenols. Thus, phthalic anhydride itself and tetrahydrophthalic anhydride are indicated by U. S. Patent No. 4,160,110 as useful as distillation inhibitors. Japanese Patent No. 48-097854 discloses stabilizing bisphenol A by distilling it in the presence of a polypropylene glycol, epoxy soybean oil, 2,2-bis-(p-glycidylphenyl)-propane or a glycerol poly(oxypropylene) adduct.

Bisphenols are stabilized against thermal decomposition by incorporating therein a quaternary aliphatic ester of ortho titanate acid according to the teachings of U. S. Patent No. 4,359,590.

A Japanese Kokoku Application No. 43-80421 teaches that the heat stability of bisphenol A can be improved by adjusting the pH of the Bisphenol A to between 2.0 and 5.0 by adding to the bisphenol A a weak acid such as glycolic, thioglycolic and polyphosphoric acid. The Japanese Kokoku Application No. 43-80421 also reported testing other acids in addition to glycolic, thioglycolic and polyphosphonic acid for comparative purposes including phosphorous, boric and lactic acid, none of which were considered to be effective. The Japanese Kokoku Application No. 43-80421 reported that the use of lactic acid as an inhibitor was no better than an uninhibited product with respect to color under conditions employed in the Japanese reference.

The present invention is the discovery that certain hydroxy carboxylic acids, not hitherto employed as stabilizers, act as excellent stabilizers (inhibitors). The hydroxy carboxylic acids of the present invention have been found to be excellent inhibitors against the degradation of bisphenols and especially for inhibiting the formation of degradation products which can cause color in the bisphenol itself or in the polymeric products made from bisphenol. The particular hydroxy carboxylic acids found to be useful as inhibitors are lactic, malic and glyceric, with lactic or malic being preferred. The acids of the present invention can also be employed as their ammonium or alkali metal salts. Lactic, malic and glyceric acids have been found to

be superior to the hydroxy carboxylic acids heretofore employed.

The acids of the present invention are particularly useful in stabilizing bisphenols during purification of the bisphenols by distillation or during separation of the bisphenols from the reaction mixture, during which the bisphenols are exposed to elevated temperatures.

5 As is known in the art, bisphenols are prepared by reacting an aldehyde or a ketone with a phenol in the presence of an acid catalyst. Thus, for example, bisphenol A is produced by condensing phenol and acetone in the presence of an acid catalyst such as hydrochloric acid, sulfuric acid or a cation exchange resin in acid form and, if necessary, in the presence of a small amount of an accelerator such as a mercaptan. Generally, bisphenol A is obtained from the reaction mixture by distilling or recrystallizing,  
10 extracting the residual bisphenol A directly from the reaction mixture or by distilling off excess phenol and water after neutralization.

Inhibitors or stabilizers employed by the prior art have been added to the feed reactants prior to the condensation reaction which forms the bisphenol. The prior art also teaches that inhibitors or stabilizers can be added at any point after the condensation reaction so long as the addition is prior to the distillation which  
15 separates the bisphenol from the reaction mixture. The hydroxy carboxylic acids of the present invention can be added to the feed reactants used to make the bisphenols or to the reaction mixture after the reaction is complete or at any point in between. While the inhibitor hydroxy carboxylic acids of the present invention can be added either to the reactants or in the reaction mixture, preferably the addition is carried out before the distillation of the bisphenol at which point degradation is most likely to occur. The inhibitors of the  
20 present invention perform well either in solution or in a melt containing the bisphenol.

The hydroxy carboxylic acids of this invention can be employed separately, in combination with each other, or in combination with other known inhibitors or stabilizers. The operable amount of the inhibitor of the present invention to be employed herein is in the range of from 2 ppm to 300 ppm based on the total weight of bisphenol. A preferred operable amount employed herein is from 5 ppm to 100 ppm and a most  
25 preferred operable amount employed herein is from 10 ppm to 30 ppm. Employing less than the above operable amount range will not satisfactorily inhibit the formation of degradation products in bisphenol. While employing more than 300 ppm herein will probably not be deleterious to the bisphenol, it is to no advantage.

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#### Test Apparatus and Method

A 4-neck, 2 L flask, containing a stirring device and thermometer, padded with nitrogen and fitted with a heating mantle was used to conduct the test for stabilizing bisphenols. Nitrogen pressure was maintained in  
35 the flask at 10 psig. A stainless steel mesh coupon was inserted through one of the necks of the flask and allowed to remain under the surface of liquid mixture contained in the flask for one hour while the flask was heated to a temperature of 80° C. The liquid mixture was continuously stirred throughout a two-hour period of heating. A 20-gram sample of the liquid mixture was removed from the flask at 1, 1½ and 2-hour intervals. Phenol and water was then stripped from the sample by a roto-evaporator at 180° C. Bisphenol was then  
40 checked for color using a Klett colorimeter. Klett readings taken by the Klett colorimeter were converted to APHA numbers based on ASTM (Pt-Co) P1209-69 standards.

The following experiments illustrate the inhibiting effect on the degradation of or the stabilization of the bisphenol by the compounds of the present invention:

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#### Example 1

To a reaction mixture containing water, acetone, phenol and bisphenol A was added 20 ppm lactic acid based on the bisphenol. The mixture was then heated to a temperature of 180° C and maintained thereat for  
50 two hours. The APHA color of the mixture was measured prior to the addition of the lactic acid and after the addition of the lactic acid from time to time during the two-hour period of heating. The increase in APHA color of a bisphenol mixture using a stabilizer of the present invention compared to that of an uninhibited bisphenol mixture (control) is shown in Table I.

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#### Examples 2 and 3

In the manner of Example 1, malic and glyceric acids were added to separate mixtures of water,

acetone, phenol and bisphenol A (same basis). The APHA color of the mixture was measured prior to the addition of the acids and after the addition of the acids from time to time during the two-hour period of heating while the temperature of the mixture was maintained at 180° C. The increase in APHA color of the bisphenol mixture using the stabilizer of the present invention is shown in Table I along with a comparison of an uninhibited bisphenol mixture (control).

#### Comparative Examples A, B, C and D

For comparative purposes, various compounds designated A, B, C and D in Table I were tested as inhibitors for bisphenol under the same conditions employed in Example 1. Results of the tests using inhibitors designated as comparative inhibitors A, B, C and D, Examples 1-3, and a control are shown in Table I.

Table I

Stabilizer Compound	APHA Color at			
	0 hr.	1 hr.	1½ hrs.	2.0 hrs.
None (control)	24	41	49	59
Lactic acid	same	30	33	41
Malic acid	same	27	29	32
Glyceric acid	same	22	26	29
(A) Citric acid	same	33	38	45
(B) Tartaric Acid	same	41	49	55
(C) Glycolic Acid	same	54	63	80
(D) Oxalic Acid	same	39	50	71

Other inhibitors known to the art and used commercially, including phosphoric acid, a tris(2,4-di-tert-butylphenyl)phosphite (IRGAFOS 168, a trademark of Ciba-Geigy Corporation) and SANDOSTAB PEPQ, were tested in the same manner as that of Example 1. The inhibitors of the present invention were shown to be superior to these commercially used inhibitors also.

#### Claims

1. A process for inhibiting the degradation of a bisphenol which comprises adding to the bisphenol as the inhibitor, lactic, malic, glyceric acids or mixtures thereof.
2. The process of Claim 1 wherein the inhibitor is in the form of its ammonium or alkali metal salt.
3. The process of Claim 1 wherein the bisphenol is the derivative of a ketone and a phenolic compound.
4. The process of Claim 3 wherein the bisphenol is bisphenol A.
5. The process of Claim 1 wherein the amount of the inhibitor employed is in the range of from 2 to 300 ppm based on the weight of the bisphenol.
6. The process of Claim 5 wherein the amount of the inhibitor employed is in the range of from 5 to 100 ppm.
7. The process of Claim 5 wherein the amount of the inhibitor employed is in the range of from 10 to 30 ppm.
8. The process of Claim 1 wherein the inhibition is accomplished during the purification of the bisphenol.